UNITED STATES OF AMERICA

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

WASHINGTON, DC

Regulatory Docket No. _____

IN THE MATTER OF THE PETITION FOR EXEMPTION OF:
MERCK & Co., Inc.

FOR AN EXEMPTION SEEKING RELIEF FROM THE REQUIREMENTS OF
TITLE 14 OF THE CODE OF FEDERAL REGULATIONS,
SECTION 91.211(b)(1)(ii)

CONCERNING SUPPLEMENTAL OXYGEN USAGE IN A GULFSTREAM G550 and G650
AT ALTITUDES ABOVE FLIGHT LEVEL 410

PURSUANT TO
TITLE 14 OF THE CODE OF FEDERAL REGULATIONS,
SECTIONS 11.63 AND 11.83

Submitted on August 12, 2021

Andrew Eldringhoff, Chief Pilot
Merck & Co., Inc.
100 Sam Weinroth Rd.
West Trenton, NJ 08628
Direct: 862-222-3080
Email: andrew.eldringhoff@merck.com

SUMMARY

Merck & Co., Inc., the Petitioner ("Merck"), seeks an exemption from 14 CFR § 91.211(b)(1)(ii). This exemption will permit Merck to operate flights above 41,000 feet (Flight Level or FL 410) without one pilot wearing an oxygen mask, provided that there are two pilots at the controls and each pilot has a quick-donning type of oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed.

INTRODUCTION AND INTERESTS OF THE PETITIONER

Merck operates a Stage 3 IS-BAO certified, part 91 corporate flight department. It owns and operates one Gulfstream G550 aircraft, two Gulfstream G650 aircraft, and three helicopters. The corporate flight department is tasked with safely and efficiently transporting executives, employees and guests across the country and around the world in furtherance of Merck's business interests.

BACKGROUND

Supplemental oxygen rules were introduced into 14 CFR part 91 through a notice of proposed rulemaking ("NPRM") on July 19, 1967 and issued as regulation on April 20, 1970.[1] At this time, 14 CFR part 121 operations were already subject to a supplemental oxygen operating regulation. In the NPRM introducing 14 CFR § 91.32 (later renumbered as 14 CFR § 91.211), the FAA noted that 14 CFR part 121's supplemental oxygen regulation was based on "extensive operating experience with the large transport-category airplanes" and the sophisticated crew training aircraft maintenance requirements, which were not present in 14 CFR part 91 at that time.[2] In the 14 CFR part 121 supplemental oxygen regulation, the FAA determined when a pilot was required to wear supplemental oxygen based on the aircraft safety records, pilot training, and aircraft maintenance standards.

The Gulfstream G550 and G650 are highly sophisticated corporate jets and the G550 is the 2003 recipient of the Robert J. Collier Trophy "for the greatest achievement in aeronautics…in America."[3] The aircraft can transport up to 19 passengers on a twelve-hour, non-stop flight, and cruise at 51,000 feet. It outperforms almost every other civilian aircraft currently in operation. In addition to impressive performance standards, the G550/650 incorporates safety features and increased system redundancy that are not common on other civilian jet aircraft.

A grant of this petition for exemption will allow Petitioner's pilots to operate their G550/650 aircraft at an equivalent, or even increased, level of safety, as explained further in this petition for exemption.

[1] 32 Fed. Reg. 10603 (July 19, 1967); 35 Fed. Reg. 6387 (Apr. 20, 1970).
[2] 32 Fed. Reg. 10602 (July 19, 1967).
[3] https://naa.aero/awards/awards-and-trophies/collier-trophy/collier-2000-2009-winners

BASIS FOR PETITION

The Petitioner, Merck, pursuant to the provision 14 CFR § 11.61(b), hereby petitions the Administrator to operate Gulfstream G550 and G650 model aircraft at altitudes above FL 410 without the requirement for a crewmember to wear an oxygen mask, provided that all required crewmembers are at their stations, each pilot has a quick-donning type of oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed, and Merck complies with the other safety requirements detailed in this Petition.

Engaging certain safety features in the G550/650 above FL 400 and meeting additional safety standards will achieve the same or a greater level of safety than complying with the current regulatory requirements of 14 CFR § 91.211(b)(1)(ii).

In accordance with 14 CFR § 11.81 (a) through (e), Merck provides the following information in support of its petition for exemption:

NAME AND MAILING ADDRESS OF THE PETITIONER (14 CFR 11.81(a))

The name and address of the Petitioner and point of contact:

Merck & Co., Inc.
Andrew Eldringhoff, Chief Pilot, Airplanes
100 Sam Weinroth Rd.
West Trenton, NJ 08628

Direct: 862-222-3080
Email: andrew.eldringhoff@merck.com

SPECIFIC SECTION FOR WHICH EXEMPION IS SOUGHT (14 CFR § 91.211(b)(1)(ii))

1. 14 CFR § 91.211, *Supplemental Oxygen,* Subsection (b):

(b) Pressurized cabin aircraft.

(1) No person may operate a civil aircraft of U.S. registry with a pressurized cabin -

…

(ii) At flight altitudes above flight level 350 unless one pilot at the controls of the airplane is wearing and using an oxygen mask that is secured and sealed and that either supplies oxygen at all times or automatically supplies oxygen whenever the cabin pressure altitude of the airplane exceeds 14,000 feet (MSL), except that the one pilot need not wear and use an oxygen mask while at or below flight level 410 if there are two pilots at the controls and each pilot has a quick-donning type of

oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed.

EXTENT OF RELIEF SOUGHT AND REASONS (14 CFR § 11.81(c))

1. Regulation and Extent of Relief Sought: 14 CFR § 91.211:

Relief from 14 CFR § 91.211(b)(1)(ii), will allow Merck to operate above FL 410 without a crewmember wearing an oxygen mask. The G550/650 aircraft design, construction, established safety history, and requirement for a two-pilot crew already provide the level of safety at high altitudes that 14 CFR § 91.211(b)(1)(ii) is meant to provide. Because the G550/650 by itself already meets an equivalent level of safety without imposing 14 CFR § 91.211(b)(1)(ii), a requirement to comply with 14 CFR § 91.211(b)(1)(ii) actually reduces overall flight safety at altitudes above FL 410. Granting the relief requested in this petition will:

- Reduce fuel consumption on flights by up to five percent, thereby reducing carbon emissions;
- Reduce congestion in the National Airspace System "NAS" by moving G550/650 operations above FL 410 and out of the same en route airspace occupied by commercial airlines;
- Reduce total supplemental oxygen consumption, which leaves a larger supply of oxygen for use by the crew and passengers during an emergency;
- Reduce the likelihood of transmitting contagions trapped in the mask, especially when the crew does not have access to professional mask cleaning equipment, supplies, or services at the aircraft's flight destination; and
- Reduce pilot fatigue, especially on long flights, because pilots will be able to eat and drink water, without coordinating a mask-wearing transfer.

THE REASONS WHY GRANTING THE EXEMPTION WOULD NOT ADVERSELY AFFECT SAFETY, AND HOW THE EXEMPTION WOULD PROVIDE A LEVEL OF SAFETY AT LEAST EQUAL TO THAT PROVIDED BY THE RULE FROM WHICH MERCK SEEKS EXEMPTION (14 CFR § 11.81(e))

1. Gulfstream G550/650 Dual Pressure Bulkheads Protect the Cabin.

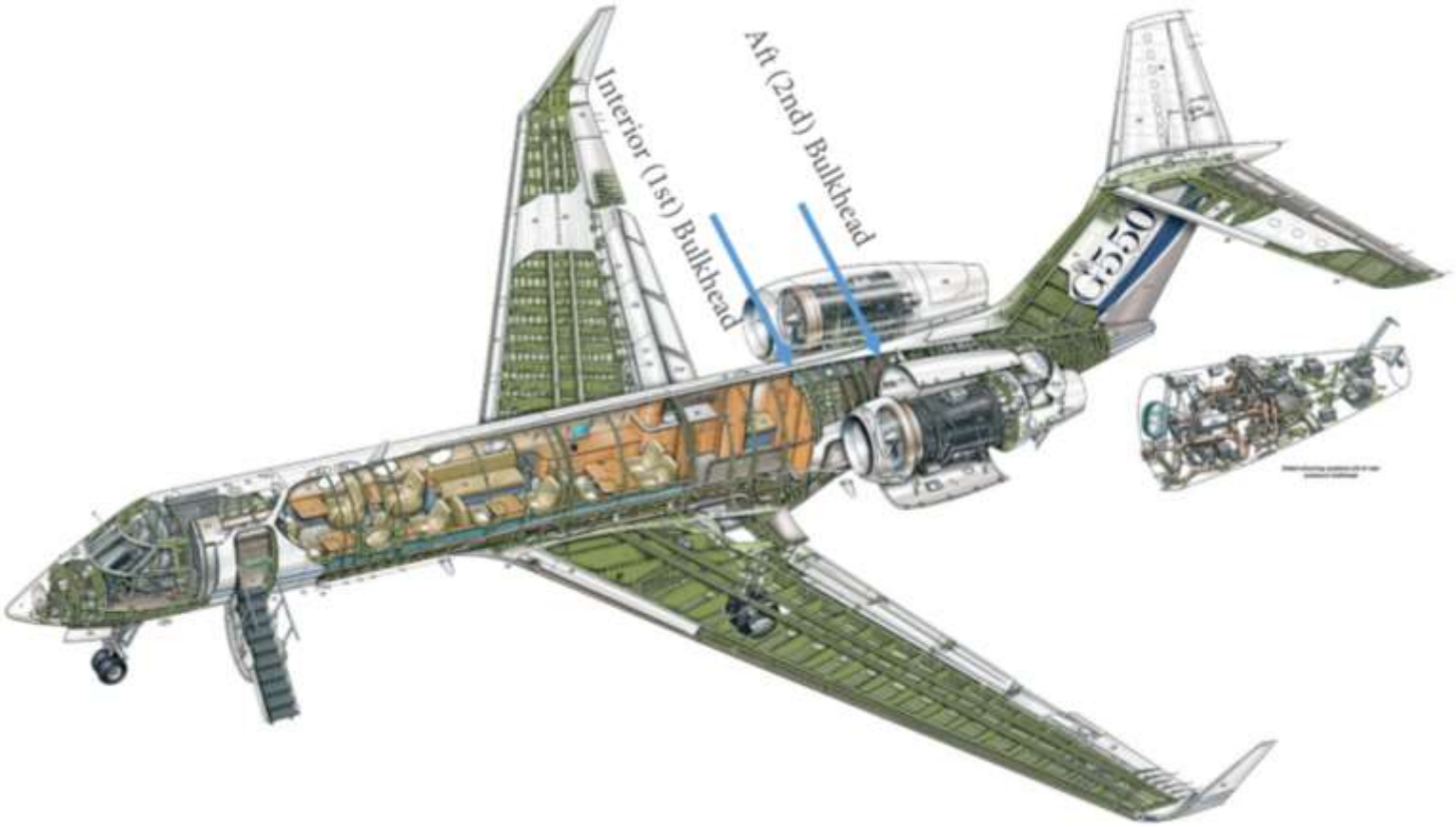
There are two types of cabin decompression events: Rapid decompressions and non-rapid decompressions. On a Gulfstream G550/650 aircraft, a flight deck annunciator illuminates to alert the pilots of the pressurization issue. During a non-rapid decompression, the cabin altitude slowly climbs to the outside MSL. The crewmembers may have minutes or hours to respond to this decompression situation. Rapid decompressions present the most dangerous decompression scenario for pilots and passengers. In a rapid decompression, cabin altitude climbs to the outside

MSL in seconds. The two most likely causes of rapid decompressions are (1) a catastrophic engine failure that punctures the fuselage, or (2) the external baggage door opens, or its seal deflates.[4]

14 CFR § 91.23(b)(1) which was renumbered as 14 CFR § 91.211(b)(1)(ii), addresses supplemental oxygen use during a loss of cabin pressure and supplemental oxygen use by pilots in anticipation of a rapid decompression. The final rule promulgated in 1970 afforded pilots the option of not wearing a mask below FL 410, as long as each crewmember at the controls had a quick donning mask available.[5] The FAA went on to note in the preamble to the regulation that only sudden decompressions require pilots to don oxygen masks rapidly.[6] The longer, non-rapid decompression events provided pilots with plenty of time to don oxygen masks and then troubleshoot the pressurization system or initiate an aircraft descent.

The FAA's concerns about rapid decompressions in the 1970s were understandable. The "jet age" was still in its relative infancy, and jet engine technology was neither as advanced nor as safe as it is now in 2021. However, the risk of a rapid decompression in a Gulfstream 550/650 today is virtually nonexistent because of G550/650's unique design and engineering. Gulfstream recognized the threat of rapid decompressions and designed the G550/650 aircraft to eliminate the two events that that are responsible for nearly all rapid decompression. First, Gulfstream equipped the G550/650 with a second pressure bulkhead.[7] The first bulkhead is located at the entrance to the baggage compartment. This bulkhead is positioned forward of the engine, which means it is forward of the engine's "blast area" in the event of a catastrophic engine failure. The baggage compartment access door in this pressure bulkhead remains closed during flight.[8] Second, if the exterior baggage door opened during flight, the cabin pressure would remain unchanged because the first pressure bulkhead remains sealed.

[4] Besides these two events, other rapid decompressions generally result from an aircraft's structural failure, such as the 1988 Aloha Airlines flight when an eighteen foot section of the cabin's skin separated from the airplane (NTSB Number AAR8903).
[5] 35 Fed. Reg. 6386 (Apr. 20, 1970).
[6] 35 Fed. Reg. 6386 (Apr. 20, 1970).
[7] Gulfstream G550/650 Operating Manual, 2A-52-40. See Exhibit B.
[8] The door may be opened to access the baggage compartment during flight if the conditions outlined in Exemption No. 17727 are met. (FAA Regulatory Docket No. FAA-2017-1009).



2. Gulfstream G550/650 Emergency Descent Mode Safety Feature Ensures an Equivalent or Higher level of Safety than 14 CFR § 91.211(b)(1)(ii).

Mechanical and structural failures cause most high-altitude decompressions. Approximately 73% of general aviation, fixed-wing aircraft accidents result from human error.[9] In most general aviation aircraft, a pilot must immediately respond to a high-altitude decompression and return the aircraft to a lower flight level with a higher oxygen concentration. If the pilot fails to initiate the emergency descent timely or incorrectly performs the emergency descent, a decompression can result in an accident.

Gulfstream included a unique feature on the G550/650 to reduce the chance of human error in a high-altitude decompression. No human response is required to descend the aircraft after a depressurization occurs. Emergency Descent Mode ("EDM") will automatically execute an emergency descent to 15,000 ft. MSL. Because no human response is required, EDM provides *at least* the same level of safety as one pilot continuously wearing an oxygen mask above FL 410, as

[9] Joseph T. Nall Report (2016) (Noting that in the Non-Commercial Fixed-Wing category, roughly 73% of accidents arose from improper actions or inactions of the pilot).

prescribed in 14 CFR § 91.211(b)(1)(ii). Appendix A contains a complete description of the Gulfstream G550/650 emergency descent mode feature.

The G550/650's EDM is coupled with the autopilot. The autopilot's EDM mode arms automatically when the aircraft's altitude is greater than 40,000 ft. MSL with the autopilot selected ON. If the cabin's pressure exceeds 8,000 feet, the following automatically occurs:

- The "Cabin Pressure Low" warning message illuminates on the Crew Alerting System (CAS);
- The autopilot changes the speed target to 340 KCAS;
- The altitude is preselected to 15,000 feet;
- The autopilot commands a left turn with a 90 degree heading change;
- The autothrottle retards power to idle (if autothrottles are not engaged, they will automatically engage);
- The airplane descends at Mmo / Vmo to 15,000 feet; and
- The aircraft levels at 15,000 feet, and the speed target changes to 250 KCAS.

With EDM installed, the pilots are not preoccupied with performing the "automatic" maneuver necessary to initiate and sustain an emergency descent. The pilots' immediate and initial focus is only to quickly don the oxygen masks and to evaluate why the aircraft is experiencing a rapid decompression. The best use of the pilots' attention and skill is to identify what caused the rapid decompression and then evaluate how to respond to that occurrence. In this situation, the pilots do not need to manually execute the emergency descent. The G550/650 will complete the maneuver faster and more accurately than the pilots. Once the pilots determine what caused the decompression, then the pilots can evaluate whether they want to continue the emergency descent via the EDM/autopilot or switch to hand flying.

Even though the EDM response is automatic, a pilot can always quickly disengage the EDM procedure by clicking the autopilot disconnect button on the control yoke. Because the EDM controls the aircraft's descent through the auto pilot, disconnecting the autopilot *always* disconnects the EDM function.

3. Merck's Gulfstream G550/650 Operations will be Conducted Pursuant to Specific Conditions and Limitations.

In seeking this exemption, Merck proposes operating its Gulfstream G550/650s above FL 410 without a pilot wearing an oxygen mask pursuant to the conditions and limitations set forth below in a-e (or other such similar conditions and limitations as the FAA may issue). Together, these conditions exceed the current regulatory requirements of 14 CFR § 91.211(b)(1)(ii).

a. Two pilots are seated at the controls and each pilot has a quick donning oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed;

b. Autopilot is engaged and functional in each axis;

c. EDM is engaged and functional and will prevent the aircraft from descending below the minimum safe altitude, or equivalent;

d. The flight crew has successfully completed recurrent training on the G550/650 aircraft from an approved part 142 training facility within the last twelve calendar months;

e. The flight crew has successfully completed a physiological training course that covers the following subject matters within the last twenty-four calendar months for items i-ix and within the last five years for items x-xi:
   i. Physics of the atmosphere;
   ii. Respiration and circulation;
   iii. Decompressions;
   iv. Stress;
   v. Hypoxia;
   vi. Hyperventilation;
   vii. Decompression sickness;
   viii. Pressure equalization difficulties;
   ix. General aviation oxygen equipment;
   x. Altitude chamber, hypobaric chamber, or reduced oxygen training environment "flight"; and
   xi. Spatial disorientation demonstrator, gyro spatial disorientation demonstrator, or virtual reality spatial disorientation demonstrator "flight".

The FAA may prescribe other conditions and limitations for safe operation.

REASONS WHY GRANTING THIS REQUEST WOULD BE IN THE PUBLIC INTEREST (14 CFR § 11.81(d))

Granting this Petition will further the public interest by reducing fuel burn, CO_2 emissions, and increasing operational safety.

1. Data Shows that Operating above FL 410 Reduces Fuel Consumption, CO_2 Emissions, and Traffic Congestion in the NAS.

Most commercial airliners operate between FL 280 and FL 410.[10] Gulfstream aircraft are designed for flight at high altitudes (the G550/650's ideal cruising altitude is between FL 410 and FL 510), above conventional airline traffic and congestion which simplifies ATC routing, allowing more direct routes for both Gulfstream aircraft and conventional airlines. More direct routing reduces fuel consumption and decreases CO_2 emissions. Gulfstream aircraft operating at long range cruise speed above FL410 can save more than 5% on fuel burn (with associated CO_2 emissions reductions). The following examples show the estimated fuel burn for two mission profiles.

Parameters:

- Gulfstream G550 aircraft
- Max gross takeoff weight
- Long range cruise speed
- Full fuel
- Zero wind conditions

Route 1: Trenton, New Jersey to Le Bourget, France

Flight Planned Altitude	Fuel Burned	Fuel Savings at FL 450
FL 390	23675 pounds	1401 pounds (appx. 6% fuel burn savings)
FL 450	22274 pounds	

Route 2: Trenton, New Jersey to Rio de Janeiro, Brazil

Flight Planned Altitude	Fuel Burned	Fuel Savings at FL 450
FL 390	31064 pounds	1706 pounds (appx. 5.5% fuel burn savings)
FL 450	29358 pounds	

An exemption from 14 CFR § 91.211(b)(1)(ii) will encourage crews to flight plan at higher altitudes, reducing fuel consumption and emissions. G550/650 aircraft flight planning for higher altitudes also means that fewer business jets will cruise in flight levels heavily populated by airlines. This also benefits the public by reducing congestion in the NAS and by increasing on-time airline arrivals and departures for airlines. The public will also benefit from reduced carbon emissions across the NAS because ATC is less likely to issue routing changes when NAS congestion decreases.

[10] 68 Fed. Reg. 61303 (Oct. 27, 2003).

2. Wearing an Oxygen Mask Decreases the Remaining Available Oxygen for Passengers and Crew in the Event of an Emergency.

If one pilot continuously wears oxygen for eight hours, that pilot consumes 68% of the total available oxygen carried on the aircraft.[11] Many G550/650 flights exceed eight hours, leading to further oxygen depletion. In the event of an emergency, such as smoke or noxious fumes in the cabin and cockpit, the aircraft's remaining oxygen supply may be insufficient to sustain safe breathing for all aircraft occupants. If the emergency occurs over water or a hostile territory, insufficient oxygen could create a life-threatening situation. Additionally, Merck travels to remote locations around the world where oxygen servicing is not reliably available. If oxygen servicing is not available, the crew may start a return flight of eight or ten hour with partially depleted oxygen tanks. An exemption from 14 CFR § 91.211(b)(1)(ii) will increase safety by increasing available oxygen on the aircraft for all occupants during an emergency.

3. Data Shows that Wearing an Oxygen Mask Increases the Risk for Transferring Contagions.

Oxygen masks are challenging to clean correctly and frequently. The Air Line Pilots Association International ("ALPA") published a white paper *Oxygen Mask Use in Aviation*, which outlined the risks to pilots if their oxygen masks are not cleaned or cleaned incorrectly.[12] ALPA requested guidance from the National Institute of Occupational Safety and Health ("NIOSH") and the Center for Disease Control ("CDC"). NIOSH/CDC advised ALPA that oxygen masks are not classified as respirators but share many of the same characteristics. Respirators are required to be cleaned before reuse under 29 CFR § 1910.134 App. B-2.[13] Because oxygen masks used on the flight deck contain built-in microphones, the masks cannot be disassembled and submerged in a cleaning solution. NIOSH/CDC then suggested a mask redesign to include a removable microphone. Since this option is not currently available, NIOSH/CDC recommended that oxygen masks are "thoroughly washed with soap and water and then wiped down with a disinfectant recommended by the manufacturer before donning."[14]

Merck cleans oxygen masks before each trip that starts from its home base. However, at many airports, especially airports outside of the United States, Merck pilots do not have access to the facility or supplies need to clean the masks thoroughly and without potentially causing damage to the masks.

[11] According to Gulfstream, one pilot breathing 100% oxygen will deplete the G550/650 supplemental oxygen supply in 11.7 hours of use. The consumption rate is 9.5L / hour for a pilot on 100% oxygen at a cabin altitude of 4850 ft. MSL.

[12] Air line Pilots Association White Paper: Oxygen Mask Use in Aviation (Oct. 2009).

[13] https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134AppB2

[14] Air line Pilots Association White Paper: Oxygen Mask Use in Aviation (Oct. 2009).

An exemption from 14 CFR § 91.211(b)(1)(ii) means that Merck pilots will only don oxygen masks when one of the two pilots leaves the flight deck above FL 350 and in the event of an emergency requiring oxygen. The reduction in oxygen mask usage will result in fewer instances where a contagion is transferred by wearing the mask. Because crewmembers operate in close proximity to passengers, a passenger may transmit a contagion to a crewmember who then breathes the contagion into the mask. Alternatively, a crewmember may contract a contagion from a mask, and then pass the contagion to the passenger. Both infected crewmembers and passengers could pass the contagion to the general public. An exemption from 14 CFR § 91.211(b)(1)(ii) may reduce the spread of contagions in the United States and internationally.

4. Data Shows that Wearing an Oxygen Mask on Long Haul Flights Increases Flight Crew Fatigue.

The Gulfstream G550/650 is a long haul aircraft designed to complete non-stop, trans-oceanic missions. Flight crews change multiple time zones enroute, which makes them more susceptible to fatigue. The G550/650 is most efficient at high altitudes where it achieves optimal speed and fuel burn, which decreases total flight time and the crew's duty day. However, when the G550/650 aircraft operates above FL 410, the flight crew faces a tradeoff. The higher cruising altitude decreases flight time and fatigue, but one pilot must wear an oxygen mask at all times. The pilot wearing the oxygen mask fatigues more quickly, which places additional stress on the crew.[15]

A pilot experiences increased fatigue from wearing an oxygen mask for an extended period. Wearing an oxygen mask hinders communication with crewmembers and ATC, which reduces the overall efficiency of cockpit resource management ("CRM"). Wearing a mask also makes eating and drinking fluids difficult. If the pilot wearing the mask wants to take a sip of water, that pilot first needs to ask the second pilot to don her oxygen mask so that the first pilot may remove his mask. This inconveniences both crewmembers and increases the likelihood of the crew missing a communication from ATC. On short flights, the inconvenience may be minimal and dehydration is less likely to occur. However, on long haul flights were a single flight crew is flying for 8 or 10 hours, the inconvenience turns into fatigue, dehydration and reduced crew communications. All of these factors reduce the overall safety of the flight and increase the chances of making an error during the flight. An exemption from 14 CFR § 91.211(b)(1)(ii) will increase safety by reducing pilot fatigue, especially on long haul flights where pilot fatigue is most likely to occur.

[15] "Use of Supplemental Oxygen/Human Factors Survey" (2016) by Aviation Medicine Advisory Service, General Aviation Manufacturer Association and National Business Aviation Association.

SUMMARY THAT CAN BE PUBLISHED IN THE FEDERAL REGISTER (14 CFR § 11.81(f))

Merck seeks an alternative means of compliance with FAR § 91.211(b)(1)(ii) that will permit it to fly above 41,000 feet (Flight Level or FL 410) without one pilot wearing an oxygen mask. This request is based on the equivalent level of safety achieved through additional conditions and limitations as well as the design features of the Gulfstream G550/650 aircraft which reduce the likelihood of decompression and provide for an automated emergency descent in the unlikely event of a decompression.

ADDITIONAL INFORMATION, VIEWS OR ARGUMENTS TO SUPPORT THIS REQUEST (14 CFR § 11.81(g))

When developing U.S. standards, the Trade Agreements Act requires federal agencies to consider international standards, and when appropriate, use those standards as the basis of U.S. standards.[16] ICAO Annex 6 ("Operation of Aircraft") does not require crewmembers to wear oxygen masks continuously during a flight. Annex 6, section 4.4.5 ("Use of Oxygen"), only requires oxygen masks to be available above 25,000 feet mean sea level (MSL). The standard states, "[a]ll flight crew members of pressurized aeroplanes operating above an altitude where the atmospheric pressure is less than 376 hPa [25,000 feet MSL] shall have available at the flight duty station a quick-donning type of oxygen mask which will readily supply oxygen upon demand."

Granting this request for exemption is not contrary to ICAO standards.

USE OF THIS EXEMPTION OUTSIDE THE UNITED STATES; REASONS WHY (14 CFR §§ 11.81(h) AND 11.83)

Use of this exemption outside of the United States is requested. The Gulfstream G550/650 is designed for long haul operations, and the majority of Merck's flights in the G550/650 involve flying outside of the United States.

CONCLUSION

Merck seeks an alternative means of compliance for FAR § 91.211(b)(1)(ii) that will permit it to fly above FL 410 without one pilot wearing an oxygen mask. This request is based on the equivalent level of safety achieved through additional conditions and limitations as well as the design features of the Gulfstream G550/650 aircraft which reduce the likelihood of decompression and provide for an automated emergency descent in the unlikely event of a decompression.

[16] 85 FR 62951.

WHEREFORE, in accordance with the Title 49 of the United States Code, Title 14 Federal Aviation Regulations, Merck respectfully requests that the Administrator grant this Petition for an exemption from the requirements of 14 CFR § 91.211(b)(1)(ii).

Respectfully submitted,
Andrew Eldringhoff, Chief Pilot
Merck & Co., Inc.
Dated: August 12, 2021

APPENDIX A

Gulfstream G550/650 emergency descent mode

Automatic Emergency Descent Mode (EDM)
Cabin Pressure Low (Red)

The autopilot has an automatic Emergency Descent Mode (EDM) that is armed anytime airplane altitude is 40,000 feet or above with autopilot selected ON. When the red Cabin Pressure Low warning message is displayed on the Crew Alerting System (CAS) with the airplane altitude 40,000 feet or above and autopilot selected ON, the following occurs:

– The SPEED target on flight guidance panel automatically changes to 340 KCAS in MANUAL mode.
– The ALTITUDE preselect is automatically set to 15,000 feet.
– The autopilot automatically commands a left turn with a 90° heading change in the HEADING HOLD mode.
– The autothrottle (if engaged) automatically retards power levers to idle. If the autothrottle is not engaged, it automatically engages and retards power levers to idle.
– The airplane automatically descends at MMO / VMO to 15,000 ft.
– At 15,000 ft, the SPEED target automatically changes to 250 KCAS.
– The autothrottle automatically sets power to maintain 250 KCAS.
– The pilot may override EDM by disconnecting the autopilot.

APPENDIX B

Gulfstream G550 Operating Manual Excerpt

2A-52-40: Baggage Compartment Doors

1. General Description:

The baggage compartment has an external and an internal door. The external door is used for loading bags or cargo in the compartment from the ramp or apron. The internal door is for the convenience of passengers, providing access to luggage while the aircraft is in flight. The internal and external baggage compartment doors may also be used as an alternate emergency escape path.

The exterior baggage compartment door is an inward and upward opening plug-type door located on the aft left fuselage below the engine pylon. Door operation is assisted by spring loaded cable reels mounted on the compartment overhead and attached to the top of the door. The door assist reels hold the door up in the full open position to allow loading the compartment. See Figure 10 and Figure 11. The area around the door is illuminated by lights mounted on the underside of the left engine pylon. When the door is closed and locked, a pneumatically inflated door seal fills the space between the baggage door and door frame on the fuselage, allowing the compartment to be pressurized and climate controlled so that it may be entered during flight.

The door has mechanically linked interior and exterior control handles installed in the center of the door that control the door locking mechanism. The exterior control handle is recessed when locked to conform to the aerodynamic shape of the rear fuselage, but protrudes out for door operation when a press-to-release button in the handle is depressed. The button is fitted with a key operated lock to secure the compartment.

An internal door provides access to the baggage compartment from the main cabin. The door is equipped with a seal in order to serve as a secondary pressure bulkhead, providing added cabin pressurization integrity in addition to the external baggage door seal. The internal door is a pocket-type door that slides open and closed on tracks. The door latch is mated to handles on each side of the door enabling door operation from inside or outside the compartment.

2A-52-40: Baggage Compartment Doors

1. **General Description:**

   The interior baggage compartment door is for the convenience of passengers, providing access to items while the aircraft is in flight. The exterior baggage compartment door, located under the left engine, is used for the loading and unloading of baggage and cargo.

2. **Description of Subsystems, Units and Components:**

   A. **Exterior Baggage Compartment Door:**

   (See Figure 10.)

   The exterior baggage compartment door is manually opened and closed with mechanically-linked handles on the inside and outside of the door. The handles rotate to position four bayonet-type latches (two forward, two aft). The bayonets extend to fit into recesses in the door frame when the door is latched. The inside handle incorporates a turn to lock / unlock mechanism in addition to an over-center condition at the latched position. The normally-recessed exterior handle can be extended by use of a pushbutton and has a keyed locking mechanism to secure the compartment. The door opens inward and upward and utilizes rollers to slide on tracks shaped to follow the contour of the fuselage. Two spring-loaded reels mounted above the door connect through two cables to fittings on the door. The reels are loaded to hold door in open position without use of any other type of restraining devices. The door has mechanically-linked interior and exterior control handles controlling the door latching mechanism. The handle is recessed when locked to conform to the aerodynamic shape of the rear fuselage, but protrudes out for door operation when a press-to-release button in the handle is depressed.

   The upper aft and lower forward bayonets compress position switches when the door is latched, communicating door position to Modular Avionics Units (MAUs) #1 and #2. The MAUs transmit door position information to the Monitor and Warning System (MWS) for use in generating CAS messages regarding door position.

   B. **Interior Baggage Compartment Door:**

   (See Figure 11 and Figure 12.)

   The interior baggage compartment door is closed during takeoff and landings. A lock is incorporated into the latch design to ensure the door remains latched. The door must remain closed at altitudes above 40,000 ft. The lock is operable from the cabin and baggage compartment to prevent crew or passengers from being locked in the baggage compartment. A CAS message appears when the internal baggage door is open at an altitude above 40,000 ft. The flight crew is required to ensure the door is closed and associated message is extinguished. When the door latch is closed, the internal venting slots are blocked by a plate inside the vent passages of the latch mechanism. When the door handle is rotated approximately 45° toward the OPEN position, the plate masking the vent slots rotates to allow air flow between the cabin and baggage compartment equalizing the pressure within both spaces.

   When open, the door resides in a pocket on the right side of the aircraft.

The door is of fiberglass / honeycomb construction. A viewing window is also provided to inspect the baggage compartment in the event of an onboard fire in the baggage area.

NOTE:

Access to the baggage compartment is available during all phases of flight at or below 40,000 feet. The interior baggage compartment door must remain closed above this altitude since opening the door compromises the auxiliary pressure bulkhead. See the restrictions on the use of the internal baggage door in the limitations section following this description.

3. Controls and Indications:

A. Doors Synoptic Page:

Both the exterior and internal baggage compartment doors are depicted on the Doors synoptic window display when the doors are open. The exterior baggage compartment door is shown in amber when open because the exterior door seal is a primary element of cabin pressurization.

B. Circuit Breakers (CBs):

The following circuit breaker (CB) powers the open position relay signal of the baggage doors to the MAUs:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
DOOR CTRL/WARN	POP	D-1	L ESS DC Bus

C. Crew Alerting System (CAS) Messages:

The following CAS messages are associated with the baggage doors system:

Area Monitored:	CAS Message:	Message Color:
External baggage door open	External Baggage Door	Amber
Internal baggage door open	Internal Baggage Door	Amber or Blue (see NOTE below)

NOTE:

Caution (Amber) **Internal Baggage Door** CAS Message: appears when internal baggage door is open above 40,000 ft and is accompanied by a two-chime aural tone.

Advisory (Blue) **Internal Baggage Door** CAS Message: appears when internal baggage door is open below 40,000 ft and is accompanied by a one-chime aural tone.

4. **Limitations:**

   A. Flight Manual Limitations:

   (1) Internal Baggage Door:

   The internal baggage door shall remain closed above 40,000 feet.